II. SeaDAS and MODIS

SeaDAS (SeaWiFS Data Analysis System) is a software package developed and supported by NASA that is intended to be used with ocean color satellite data. It is freely available at http://seadas.gsfc.nasa.gov. SeaDAS is built on IDL and runs with a licensed version of IDL. A version of SeaDAS is also available that used an imbedded IDL core and *does not require* an IDL license to run. Both versions can run in Interactive and Command-line modes, and batch mod processing. The examples that follow are prepared in Interactive mode.

Although it was originally used for SeaWiFS processing, recent upgrades have included the ability for SeaDAS to read in MODIS level 2 data, display MODIS flags, and remap level 2 granules. It is NOT able to process MODIS data from level 1 to level 2. The codes for processing MODIS data from level 1 to level 2 are available from the website:

http://directreadout.gsfc.nasa.gov/download_technology/db_software.cfm#softwar

NOTES:

1. The MODIS level 2 granules that will be used are in the directory */net/home/modis/images/l2*.
2. The MODIS level 3 files are in */net/home/modis/images/l3*.

Start SeaDAS – At the command prompt, launch SeaDAS by entering 'seadas' and hit 'Return'.

Example of loading *MODIS Level 3 Mapped* products into SeaDAS

The files in the */net/home/modis/images/l3* directory are global 4km monthly and 36km weekly images. The 4km images are very large.

1. From the *seadisp* widget, select 'Load→MODIS Oceans Data'.
2. At the 'MODIS Filename' prompt, select 'MO04MM26.chlor_a_2.ADD2001121.004.2002211074834.hdf.' No geofile is needed.
3. Set the Pixel Sample Rate and the Line Sample Rate to 4 – computer memory isn't large enough for the full 4km resolution. Setting these to '1' will load the entire 4km global image, but will cause these computers to grind to a halt.
4. Select the 'chlor_a_2_mean' product - the only one (see *NOTE 1), and load it in.

5. To load a color palette, hit the '*Functions*' button on this window, and go down to the 'Color LUT→Load Color'. A window appears with a variety of color palettes. I recommend either the 'RAINBOW' palette (13th in the list), or Miami's palette 'Rainbob' which is second to last. Once you've highlighted a palette, you need to hit the '*apply*' button for the palette to take effect in the image window.
6. The initial 'look' of the image will not be correct when you first display it. The data needs to be 'rescaled'. To do this, go to the *Setups* → *Rescale* option of the window with the level 3 image.
7. For *Scale Type*, select "*Log*". The Scale Min value of 0.01 is good, but the Max value can be adjusted. Try 65.0, and hit '*Redisplay*'.
8. Repeat steps 2-4 to view other products. When two windows are open, they will be displayed with the same color palette. There's a way to display two separate color palettes but that is beyond the scope of this exercise.

*NOTE 1: MODIS Oceans Level 3 products are found in individual files. Thus, there is only one product per level 3 HDF file.

Example of loading MODIS Level 2 products in SeaDAS

All MODIS product groups can be read into SeaDAS. There are several ways to get them in. Since they are in HDF format, they can be read in as 'HDF' files. However, SeaDAS has a special option for reading in MODIS Ocean level 2 granules, which this example will demonstrate.

1. From the *SeaDAS Main Menu* widget, select '*Display→seadisp*'. The *seadisp* widget will appear.
2. From the *seadisp* widget, select 'Load→MODIS Oceans Data'. Another widget appears.
3. For the 'MODIS Filename' prompt, select the file 'MODOCL2B.A2001095.1605.004.2002186051608.hdf'.
4. For the 'Geolocation Filename', select the file 'MOD03.A2001095.1605.003.2001216184915.hdf' (see *NOTE 1).
5. Set the Pixel Sample Rate and the Line Sample Rate to '1'.
6. Select the 'chlor_a_2', 'chlor_a_3', and 'quality' products and then hit the 'Load' button (see **NOTE 2).

7. A new window appears – this is the *Band List Selection* window which will list any products loaded into SeaDAS. To display the 'chlor_a_2' product, highlight it in the list and then hit the 'Display' button at the bottom of this widget.

8. A new window appears with the image in a gray scale. You may need to scroll around to find familiar features. To expand the window, drag the corner *very slowly*!

9. To load a color palette, hit the '*Functions*' button on this window, and go down to the 'Color LUT→Load Color'. A window appears with a variety of color palettes. I recommend either the 'RAINBOW' palette (13th in the list), or Miami's palette 'Rainbob' which is second to last. Once you've highlighted a palette, you need to hit the 'apply' button for the palette to take effect in the image window.

10. To load a coastline or land mask, go to the 'Setups' button at the top of the image window. Hit either the 'Coastline' or 'Land Mask' button. A new widget will appear with a few options. To generate a decent coastline coastline or landmask, make sure the 'CIA DB Resolution' is set to 'High' (~1km). You can set the color, line thickness, and other parameters in this window to your choosing. Using the 'High' resolution database can take a few minutes for coastline or landmask generation, so proceed at your own risk.

11. The coastline and landmask are actually displayed in a separate 'plane' and are not part of the image. All graphics generated within SeaDAS are placed in this plane. To clear the coastline, landmask, or any other graphics, go to the 'Functions' button on the image window, and select 'Graphics Control → Erase All'. This will clear the entire graphics plane without affecting the image itself.

*NOTE 1: MODIS Oceans Level 2 files have geolocation information saved in a separate file – the MOD03 files. These need to be loaded as separate files in SeaDAS for anything to do with georeferencing (e.g., coastline placement or image re-mapping).

**NOTE 2: Many Widgets (or Windows) will remain open in SeaDAS after you have used them. You can 'Quit' any of these after use to reduce the clutter on the computer screen.

Quality flags

Quality flags can be displayed in SeaDAS. All MODIS Quality products have a value of 0, 1, 2 or 3. In general, the quality levels are described as follows:

0 – good
1 – questionable
2 – cloud
3 – bad

Example of Quality Flag display in SeaDAS

1. From the *seadisp* widget, select '*Load→MODIS Oceans Data*'.

2. Hit the first 'Select' button for the 'MODIS Filename', and select the granule 'MODOCL2B.A2001095.1605.004.2002186051608.hdf', and hit the '*Ok*' button.

3. Hit the second 'Select' button for the 'Geolocation Filename', and select the granule 'MOD03.A2001095.1605.003.2001216184915.hdf', and hit the '*Ok*' button.

4. Set the Pixel Sample Rate and the Line Sample Rate to '1'.

5. Select the 'chlor_a_3' and 'quality' products and then hit the '*Load*' button.

6. Display the 'chlor_a_3' product from the *Band List Selection* window.

7. From the *seadisp* widget, select '*Functions→MODIS Quality Flags Display*'. A new window appears.

8. You can select from here which quality flags to display in a window with an image. The data will be sent to the graphics plane. To show where 'Quality 1' pixels are located, slide the top bar to the band number of the quality flags found in the *Band List Selection* (i.e., it is the number to the left of the 'quality' product).

9. Slide the next bar to the window number containing the chlor_a_3 image, and '*Load*' the image.

10. To display other quality flags, select those from the list and hit '*Load*' (see *NOTE 1).

*NOTE 1: In order to load individual flags without displaying any previously loaded flag, flags must be cleared. This is done by selecting 'Flag Function Menu→ Clear All Flags' from the *MODIS Quality Flags Display* window.

Remapping

The products of MODIS Oceans Level 2 granules can be remapped to a variety of projections using SeaDAS. Remapping transforms the original image from 'satellite' view to a standardized projection. This allows for images from different granules to be composited, or granules from different days to be put into the same projection. This example takes you through an 'interactive' session, but this type of activity is well suited for 'batch-mode' processing.

Example of Remapping MODIS images in SeaDAS

1. Load the 'chlor_a_2' product in as illustrated in the 'Loading in Products' example above (skip this if you've already loaded it into SeaDAS).

2. Load the 'sst' product from the MOD28L2 product group.

3. From *seadisp* widget, select Functions→Projection. A new window appears.

4. From this window, highlight the 'chlor_a_2' and 'sst' products in the Selection list at the top (it will automatically be placed in the 'Selected for Projection' list).

5. Under 'Map Projection Inputs', set the following values:

    a. Projection → Conic (Lambert's)
    b. Center Lat → 40.0
    c. Center Lon → -70.0
    d. Rotation → 0.0
    e. Standard Parallels → 36.1667, 43.833 (into separate fields)

6. Click the 'No' option for 'Automatically load defaults' line.

7. Select the 'Set Scale' option, and set the 'Scale' to 5.0028125e+06.

8. Set the output size to 1024 x 1024.

9. Hit the 'Go' button – this will take a few minutes.

10. A new image should eventually appear in the *Band List Selection* window.

11. Display it, and check it out.

True color generation

True color composite images can be generated by assigning radiance bands as Red, Green and Blue intensities. These can assigned using level 1b or level 2 data. Here we will use the MOD09 file (a MODIS Land product) and the MODOCL2 file to generate true color composites. The advantage of using MOD09 is that you get clouds and land in the true color scene, whereas with MODOCL2 these are masked out in the level 2 processing and you are dealing only with radiances from the 'water' pixels. Also, atmospheric effects are removed using the MODOCL2 file, while some atmosphere is retained in the MOD09 file.

Example of True Color Generation from MOD09

1. Using *Seadisp→ Load → HDF*, open MOD09.A2001095.1605.hdf.

2. Select Band 1, 3, and 4 (1km or 500m), and hit 'load'.

3. Bring up the *Seadisp→Load→True Color* widget.

4. Select the 'Band List' option at the top.

5. Enter the 'Band number' from the Band List Selection as follows:
   R band = Reflectance Band 1
   G band = Reflectance Band 4
   B band = Reflectance Band 3

6. Enter the following numbers for the slope and intercept fields:

Band	Slope	Intercept
R	4	5
G	4	40
B	4	1

7. Hit 'Load'.

8. A new image will appear in the Band List Selection. Display the image.

9. These numbers may have to be adjusted to get what you think is a 'correct' looking RGB. Adjust the slope and intercept values, and hit the 'Go' button to generate new RGB images. Let me know if come up with any 'magic' combination.

Example of True Color Generation from MODOCL2

Repeat steps, except load MODOCL2.A2001095.1605.004.2002186051608.hdf in step 1, and in step 4, designate nLw_665 (‘Red’), nLw_551 (‘Green’), and nLw_412 (‘Blue’). Start with values of 50 for the Slope and 10 for the Intercept, and experiment from there.

Batch processing in SeaDAS

Remapping MODIS images using SeaDAS can be done in batch-mode. Batch-mode processing requires a licensed installation of IDL. Batch-mode programs can be run from a shell command line, or as an automated cron job. The example that follows and the routines provided can be setup to run from either.

In this example, select MODIS Level 2 products (i.e., chlor_a2, OCL2B quality, and SST) to be remapped to a defined projection. The following files in the ‘batch’ directory used for the batch job are:

- *do_modis_remap1* - starts seadas in batch mode and executes *do_modis_remap2*
- *do_modis_remap2* - compiles and runs inside SeaDAS *do_modis_remap3*
- *do_modis_remap3* - executes the *l2_modis_remaps.pro* routine

- *l2_modis_remaps.pro* – the control program for remapping MODIS L2 granules. This routine calls *l2_remaps_modis_ocl2b.pro, l2_remaps_modis_sst.pro, l2_remaps_modis_qual_flags.pro*.

- *l2_remaps_modis_ocl2b.pro* – this routine remaps the ‘chlor_a2’ product from the MODOCL2B group to the specified projection. It will generate a composite remap from the given input files, and save this to a new hdf file. Other products from this group to be remapped can be added in this file.

- *l2_remaps_modis_sst.pro* – this routine remaps the ‘sst’ product from the MOD28L2 group to the specified projection. It will generate a composite remap following the same granules used in *l2_remaps_modis_ocl2b.pro,* which is appended to the same output hdf file. Other products from this group to be remapped can be added in this file.

- *l2_remaps_modis_qual_flags.pro* – this routine remaps the ‘quality’ flags from the MODOCL2B group to the specified projection. It will generate a composite remap from the given input files.

- *l2_remaps_modis_mod09.pro* – this routine remaps bands 1, 3, and 4 at 1km from the MOD09 group to the specified projection. It will generate a composite remap from the given input files. These bands can be used to generate true color images.

1. Copy these files to your home directory –

   cp * ~ <CR>

2. Edit the do_modis_remap1 file and change the path:
   emacs do_modis_remap1

   Change the directory line (first line) to point to your directory and save the file:

   Example for user 'modis11':

   cd /net/home/modis/modis1

3. Edit the l2_modis_remap.pro file and change the *outdir* to your home directory (e.g.,set outdir as *'/net/home/modis/modis1/'* for user *modis1*).

4. To run the batch job, at a command prompt type *'do_modis_remap1'* from the batch directory.

5. You can run seadas to check out the output images by loading them in as 'SeaDAS Mapped' images using *Seadisp→Load.*